

MODERN BULLET WOUNDS.

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THE history of bullet wounds is being rewritten each day as the Russian-Japanese War progresses.

The experience on such a large scale gained in this war will settle the theories as to the effects of modern bullets which were advanced during the Spanish-American and South African Wars. The Filipino insurrection was but a transition period in which the effects of the old bullets could be contrasted with the new.

All the great powers have laid aside the soft lead, large-sized bullets used in the Springfield, Martini, and Remington rifles, and are now using the small caliber, nickel-jacketed bullet with smokeless powder. And though the rifle may differ as to name, be it the Krag-Jorgenson, Lee-Medford, Mannlicher, Mauser, Mouzin, or Arisaka, yet the wounds produced are the same.

Russia has armed her land forces with a rifle designed by Colonel Mossine (or Mouzin) which is similar to the Mauser. It has four grooves and gives an initial velocity of 2075 feet. The magazine box is vertical under a receiver attached to the trigger guard, has no cut off, and holds five cartridges, which are introduced from a clip. The bullets are of hardened lead with cupro-steel envelopes and weigh 310 grains. The caliber is .275 inch; range, 2096 yards; pitch of trajectory at 1970 feet is seventy-two feet. Smokeless powder is used. The naval forces are armed with this same rifle of 1891 design and also with the Lee straight-pull, caliber .236 inch, which is the smallest caliber in use in any army.

Japan has part of her army supplied with the Murata rifle, which is constructed on the unwieldy fixed magazine tube sys-

tem, and has a range of 2187 yards. This rifle has a tubular magazine under the barrel, holds eight cartridges, and is charged through a receiver, a single cartridge at a time. It weighs over eleven pounds when loaded and has a caliber of .315 inch. The majority of the Japanese troops are equipped with the rifle designed by Colonel Arisaka, type of 1897, which is made in Japan, and is almost identical with a Mauser rifle, though a little superior to it. It has a .25-inch caliber, with six grooves, an initial velocity of 2378 feet, and pitch of trajectory at 500 yards of only 3.87 feet. It holds five cartridges in the magazine, which are introduced on a clip. The range is 2500 metres. The bullet is of hardened lead with a German-silver jacket and weighs 158 grains. Smokeless powder is used.

In comparing the rifles of the two armies, it is easily seen that Japan has a smaller bullet with greater penetration, flatter trajectory, and greater range. Yet the difference is very little if the wounds produced are compared, as all high-velocity small-caliber bullets give practically the same wounds, according to my experience with Mauser and Krag wounds in Cuba, the Philippines, and China.

The chief interest to the surgeon in war wounds centres about the high-velocity bullet, and its effect on the human system. The wounds produced by it can be better understood if the chief points of difference between the new and old rifles are remembered. 1st, The increased velocity; 2d, decreased caliber; 3d, shape and weight of the bullet; 4th, construction of it; 5th, addition of a magazine; 6th, the use of smokeless powder. These changes have produced increased rapidity of fire, increased range, a flat trajectory, and thereby an increased danger zone. The increased velocity has no practical bearing on wounds in the soft tissues, and its most obvious ill effects are seen in the different parts of the nervous system, according to Makin's experiences in the South African War, but a notable exception must be made in the case of brain wounds, for in many cases of men shot in the head, and found dead on the field, I have seen the entire brain tissue pulped. The skull bones, however, were the cause of this, as the greater effect of

the high-velocity bullet was seen in the high resistant structures,—the bones and their contiguous soft parts.; the velocity being imparted to the bones, and by them to their surroundings. The decreased caliber makes a smaller wound, and a smaller area means less resistance on the part of the tissues, and thereby less stunning effect. The shape of the bullet offers less resistance, and thus gives greater penetration, too. The hard mantle used in its construction renders alteration either without or within the body more difficult, making lacerating wounds rare, and restraining the bullet from leaving in the tissues detached fragments. The addition of a magazine, smokeless powder, the increased rapidity of fire, and lengthened range, all tend to decrease the number of sword and bayonet wounds, as the engaging sides can rarely get close enough for their use. The trajectory or curved flight of the bullet is flatter than in the old style. The high-velocity bullet when fired from the rifle at the shoulder, which rifle has been sighted to 500 yards, can cover some part of the standing man the whole extent of its flight. This vastly increases the danger zone, and therefore increases the number of the wounded.

In dealing with the general character and nature of wounds caused by this high-velocity projectile, two classes are easily apparent. (1) Those injuries from the direct effect of the bullet on the tissues in which it comes in contact. (2) Those injuries resulting from indirect or remote effect by the transmission of the force of the bullet laterally to surrounding tissues and organs. This latter class, if the hydrodynamic theory is correct, is caused by the bullet displacing the fluid in the tissue cells, and transmitting a wave effect through the neighboring parts. Stephenson, in his "Wounds in War," has an excellent defence of this theory, illustrating it by the effect of a high-velocity bullet on a closed leaden can filled with water, which badly shatters the can by the effect of the waves of water generated thereby. The tissues and covering of the brain are analogous to this closed can and its contents, and the effect is generally the same.

Reverting to the first class—the direct effect on the tissues,



FIG. 1.—Case I. Entrance wound, Mauser bullet, undeformed, distance less than fifty yards.
Left ankle.



FIG. 2.—Case I. Exit wound, Mauser bullet, undeformed, distance less than fifty yards.
Left ankle. Shows explosive effect at short range.



FIG. 3.—Case III. Stellate entrance wound, Krag bullet, undeformed, distance less than fifty yards. Right ankle.



FIG. 4.—Case IV. Entrance wound, Krag bullet, undeformed, right knee, distance less than fifty yards.

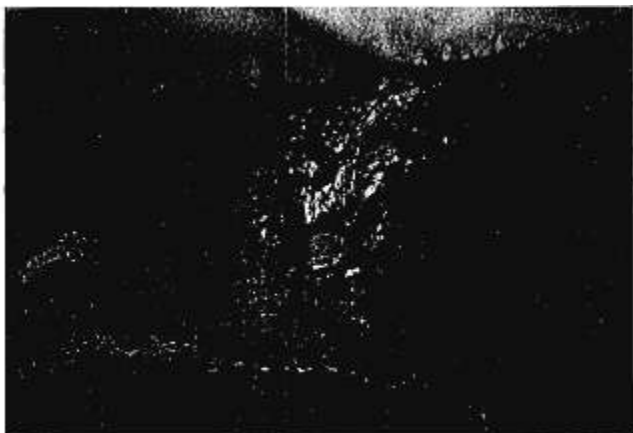


FIG. 5.—Case IV. Exit wound, Krag bullet, undeformed, near popliteal space right knee, distance less than fifty yards.

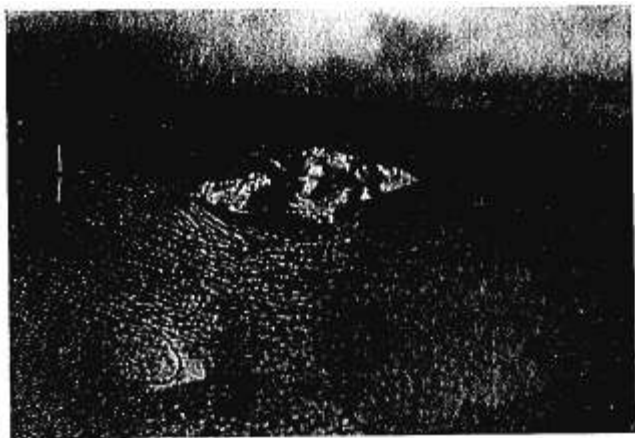


FIG. 6.—Case II. Entrance wound, Mauser bullet, undeformed, distance less than fifty yards. Over left tibia. Notice splitting of skin, not caused by bullet, but by fragments of bone flying upward, and, as but little flesh being between skin and tibia, the skin is split by them. Illustrated by ends of a board flying up when board is broken in the middle. Notice X-ray picture of this.

the entrance wound is often described as having a punched-in look. It is more a punctured or perforating injury than those seen in the Civil War. When the bullet impinges at right angles to the body the entrance is circular, and slightly less in diameter than the projectile. The edges for a small fraction of an inch are discolored, and the skin has a contused look. However, when the wound has been received at a very short distance, or at the extreme range, the entrance wound is often found to be larger than the diameter of the bullet. In Case No. 6 of the sixty-nine killed and wounded in the attack on Laoag, Luzon, April 17, 1900, the entrance aperture was nearly an inch in diameter in the right axilla. It was received at a distance of less than fifty yards. The wound was circular, made by a Krag bullet, and was undoubtedly the wound of entrance, as in its exit the bullet blew off the top of the skull. This has been explained to me by ordnance officers in the army, that the bullet in its first few yards of flight has not yet steadied itself, and its axis of rotation has not become parallel to the line of its trajectory, as only the last half of the bullet is caught up by the rifling of the gun-barrel. This may be the true explanation. At extreme range the wound of entrance is also larger than the diameter of the bullet. Ordnance officers also give the causes for this in the tendency to wobble when the bullet has lost almost all its velocity and rotation. An example of that is the case of a private of the Thirty-third United States Infantry at Tagnadin Pass, whose wound of entrance was over three-fourths of an inch in diameter and circular. It was received at a distance of over 2000 yards, and must have been near the extreme range of the bullet, as it lodged in the brain substance. Nancrede gives the true explanation of the lodgement and deflection of the majority of modern small-arm projectiles as due to the laws of physics and ballistics, and not due to ricochet; the hypothesis being that from 1000 yards to 1500 yards the bullet tends to revolve on its short axis and is thereby easily deflected. (See Figs. 1, 2, 3, 4, 5, and 6.)

Wounds of entrance are atypical, also when received at an angle or from ricochet. Out of sixty-nine dead and wounded

at the battle of Laoag, thirty had atypical wounds of entrance. As the fighting was at short distance, few of these were ricochet wounds, and the bullet had entered at an angle, sometimes scoring the skin for several inches before penetrating it. Ricochet wounds are contused and lacerated, as well as multiple, as a rule, and in many instances stones, gravel, and dirt are carried in by the bullet or its fragments. For four months in the spring of 1900, I occupied my leisure moments in extracting gravel and bullet fragments from the multiple wounds in the hips of a teamster wounded by ricochet, by the accidental discharge of a Krag at a distance of ten feet, the man having been standing in a gravel road. It is needless to add that supuration is to be expected in such cases.

Exit apertures vary widely. The skin being unsupported on the exterior accounts partially for the exit being larger than the entrance. At normal velocity the exit aperture often resembles the entrance so closely as to be difficult of differentiation. At low velocity, it may be a mere slit, so small as to defy discovery.

Senn, in his Lane lectures in San Francisco, July, 1899, told of a case in which he had opened the knee-joint for a retained bullet, as he could find no exit. As nothing could be found in the joint, diligent search over the popliteal space revealed a slit in the skin but one-half inch long, which he had overlooked, much to his disgust. A proper use of the Röntgen ray obviates such needless operations. When the bullet emerges through the skin very obliquely, a long ditch-like wound results, much wider than one would suppose, and very intractable in healing. Unlike the slit exit, the skin retracts, leaving a gaping wound. At the engagement at Vigan, Luzon, December 5, 1899, an insurgent soldier, lying down behind the stone fence at the hospital, raised his head to look out. A Krag bullet struck him on the top of his head, raised a thin plate of bone, with adherent scalp, and passed out near the occipital prominence. The wounds of entrance and exit were long ovals, and a gutter fracture of the skull resulted without brain lesion. Not only were the wounds months in healing, but the

intervening bridge of scalp sloughed off, and I removed a thin plate of bone covering about one square inch before resolution would take place. The horrible wounds of exit, due to the supposed explosive bullets, or to lesions of bone forcing the internal tissues through the skin, will be spoken of under the effect on bones.

The track of a normal bullet through the body is straight. The high-velocity bullet does not run along the ribs, and play hide and seek in the body as the old has done. A private of the First Nebraska Regiment, wounded in the Philippines, came under my care in June, 1899. He had two oval scars, the first at right angles to the axis of the body, near the left anterior superior spinous process; the other parallel to the axis of the body just below the umbilicus. He informed me that the surgeon had told him that the ball had been deflected at almost a right angle from the pubic bone, and for several weeks he had discoloration of the skin over this angling track. My own experiences lead me to believe that such a course for a high-velocity bullet is impossible. Through muscular tissue this bullet slits and tears, perforates cancellous bone, splinters and comminutes dense bone, and bites out pieces of nerves and blood-vessels. A hard, fibrous cord marks its track after healing.

Localizing the bullet wounds, and at the same time noting the indirect effect of a bullet on the tissues concerned, injuries of the head may well be dealt with first. The surgeons of the Portland Field Hospital in the South African War remarked that "wounds of the head still continue to be the most fatal of all the injuries received on the battle-field." Of the 305 United States soldiers killed in action in China and the Philippines for the year ending June 30, 1901, seventy-eight had fracture of the skull. This number of fatalities was only exceeded by penetrating wounds of the thorax, which caused 101 deaths. In the Civil War, 57 per cent. of all gunshot fractures of the head were fatal. In the Spanish-American War, as near as I can learn, 64 per cent. were fatal. According to the Surgeon-General's report for the year ending June 30, 1901, 94 per cent. of all

gunshot fractures of the head received in action died. This would seem to imply that, notwithstanding antiseptic treatment, the modern bullet is not as humane in skull injuries as the old. The reason of this is the explosive action on bone and on cavities filled with fluids or semifluids. This action is noted in distances less than 500 yards approximately. Forwood speaks of the fact that after 1600 metres clean perforations of the skull occur. Freer cites the case of a Mauser bullet at 1000 yards penetrating the centre of the forehead and emerging at the right temple. Entrance and exit wounds were clean-drilled holes. The patient was convalescent in three months. At extreme range the bullet is humane. At the general hospital in Old Point Comfort, July, 1899, I examined a negro soldier who, at the battle of Santiago, had been shot by a Mauser bullet at over 1500 yards, which penetrated his skull from occiput to the ramus of the jaw. Some paralysis at first was present, which at the time I saw him had entirely disappeared. It seems improbable that the same kind of bullets could cause the following injuries, which were taken from my case-book, occurring at the battle of Laoag, Luzon, P. I., April 17, 1900.

CASE No. 6.—Native Filipino, found dead shortly after the fight; distance shot less than fifty yards. Entrance wound about one inch in diameter in right axilla. Exit, whole rear of the head blown out, cranial contents gone from parietal to parietal, all gone clear down to the base of the skull.

CASE No. 7.—Native Filipino, dead. Distance, probably less than 100 yards. Entrance wound three-fourths of an inch by three-fourths of an inch centre right ear. Exit, the entire left side of head including ear gone, with fracture and displacement of all the rest of the bones of the skull, as well as malar and superior maxillary of left side of face.

I have records of other cases almost as severe as these two cited. These were all produced by Krag bullets undeformed, and not filed at the apex to render them explosive. The terrible injuries to the skull lead many to believe that the bullets had been tampered with, but, as close inspection was made of our

ammunition before the fight, it must have resulted from the velocity of the bullet alone. "Gutter" fractures, or those resulting when the bullet chips up a portion of the bone, leaving a neat "gutter" behind, are rare, and also rarely fatal, as in the case cited. The gunshot fractures in the Boer War have generally been received at long range, and consequently do not show the explosive effects as seen in the Philippines, where such wounds were usually at short range, due to ambushes.

Von Bergmann tersely sums up the head injuries as follows: At fifty metres the scalp is preserved and continues to hold the skull together, though the latter is broken into many fragments. At 100 metres the destruction of the skull is somewhat less, though two zones of comminution can be grouped around the wounds of entrance and exit. At increasing range the damage decreases. At 1800 metres and upward we have clean-cut bullet-holes. At 2700 metres the bullet remains embedded in the brain.

Wounds of the face gave little trouble unless some important nerve was cut, as the bone and cavity conditions were absent. However, when the inferior maxillary bone was involved, much annoyance was often caused by the non-union of the fragments, as in the case of Captain Gibson of my own regiment, where excessive destruction of this bone left him with a useless lower jaw. Retained bullets in the face were sometimes found.

Borden reports a case of a private in the First Nebraska Regiment with retained bullet in right antrum of Highmore; localization by X-ray and recovery. This case came under my observation at the United States General Hospital, San Francisco, June, 1899. Ankylosis of the jaw and retinitis with atrophy of right eye were present. An unsuccessful attempt, after two radiographs had been made, to remove the bullet was followed by its complete removal August 16, 1899, by Major A. C. Gerard, Surgeon, United States Army. Bullet was found to be a deformed Remington. The last time I saw the case was September 7, 1899, when almost complete recovery had taken place. The patient, however, at that time was suffering far more from an

X-ray burn six inches in diameter than he had from the presence of the bullet. Borden also reports a case of lodged bullet in the brain with recovery. From conversation with many army surgeons, I am led to believe that recoveries are exceedingly rare in such cases. In the one case I had, a private in the Thirty-third Infantry, at the battle of Tagnadin Pass, December 4, 1899, death took place within twenty-four hours. The distance was nearly 2000 yards; entrance over fissure of Rolando, left side, bullet presumably had passed towards the base of brain, and was not found. Patient unconscious from the receipt of injury with total paralysis of right side. The bullet had penetrated so deeply and the condition of the patient such that it was not followed to its lodgement.

Wounds of the neck were of the gravest importance on account of the large blood-vessels and nerves there. Some of the narrowest escapes occurred in this region. This class will be noticed under wounds to blood-vessels and nerves.

Wounds of the chest have not been given sufficient prominence by the writers on high-velocity projectiles, I believe, and my statement is based on the Surgeon-General's report for the year ending June 30, 1901, that the largest number of deaths in action—101—were due to wounds in the chest. So many marvellous recoveries have been recorded that one is apt to forget that such injured usually die on the field of action. If they live long enough to reach a hospital, the great majority, nearly 80 per cent., recover. The percentage of mortality in the Civil War, of penetrating wounds of the chest, was 65 per cent. I am unable to get accurate figures for the Spanish-American or Boer Wars, though Greenleaf, in the former, reports twenty-four cases, with nine deaths, or 37 per cent. fatal. These do not, I believe, include any found dead on the field from chest wounds. In 1901, in the Philippines, of all penetrating wounds of the chest in action, 74 per cent. were fatal. The wounds may be divided into two classes. (1) Those of bronchi and lungs. (2) Those of heart and blood-vessels. The first are numerous, and rarely fatal unless the root of the lung is involved, in which case most of the patients succumbed on the field; or in those

cases where the bullet was lodged in the lung tissue. Repeatedly have I seen men shot anteroposteriorly, and have little hæmoptysis and slight hæmothorax, the wound closing up beautifully, with no infection or untoward symptoms. The celebrated case reported by the surgeons of the Portland Field Hospital in the Boer War shows what a slight shock these bullets make: "A man, whilst firing in the prone position, felt his pipe break in his breeches pocket, and presently put his hand down to feel what had happened. He withdrew his broken pipe, and also a bullet, and then finding some blood on his hand, thought he must have been wounded. As it turned out, he had been hit by a bullet, which entered the shoulder and traversed the lung and abdomen, and yet had caused him no pain or sense of injury."

Lodged bullets give rise to much pain and often severe hæmorrhage. A soldier under my care, in the United States General Hospital at San Francisco, had one lodged in the upper lobe of his right lung, according to the radiograph. At recurring intervals, about ten days apart, he would be seized with a violent pain, and a severe hæmorrhage through the mouth would ensue. He grew weaker and weaker and probably died, though I was unable to follow the case through on account of orders for foreign service. Pain in breathing was also noticed in those cases where ribs were fractured.

Wounds of the heart and large blood-vessels of the chest were seen in autopsies only. I have seen one man with a wound one inch above the left nipple, and also saw one in a similar place below the left nipple, and no symptoms of involvement of the heart. Recoveries uneventful in both cases.

Wounds of the spine were similar to those seen in our civilian hospitals, and little could be done for them. The inevitable resulting paralysis and decubitus rendering the patient a burden to himself and all concerned. The bony column surrounding the cord gave a high-velocity bullet awful opportunity for explosive effect. Sixty-two per cent. in the Spanish-American War were fatal, which is 7 per cent. more than in the Civil War.

Wounds of the abdomen have caused much discussion and many differences of opinion. They still remain of the gravest character, and are far more fatal than the hospital records show. Ninety-one per cent. of those soldiers with penetrating abdominal bullet wounds in the year 1901 in our army were fatal. Of those who survived long enough to be carried to a hospital, 80 per cent. of these were fatal. At the battle of Laoag, Luzon, thirty-three of its sixty-nine killed and wounded had penetrating abdominal wounds. Twenty-six of these died before I could see them. The remaining seven died within seventy-two hours. It is exceedingly exasperating to see these cases passing away, no matter whether conservative or operative treatment is used. Of the organs wounded, the spleen produced death quicker than any other, which was undoubtedly due to hæmorrhage. The liver would allow perforation, providing the large blood-vessels were not touched. The only case of recovery in my own practice from penetrating wounds of the abdomen was of this class:

A Filipino woman was walking along the streets of Laoag, Luzon, in October, 1900. A native scout, twelve feet away from her, in cleaning his Krag carbine accidentally discharged it. The bullet entered the woman's abdomen, right side, immediately beneath the eighth rib, at the edge of the rectus abdominalis, and passing backward and to the right emerged in the same transverse plane two inches posterior to the axillary line. For a week her temperature was over 102° F., at the end of which time it gradually fell to normal, with uneventful recovery. The entrance and exit wounds were small and quickly healed. No surgical interference was used.

Wounds of the stomach were not so fatal as those of the intestines, though in my own experience I have never seen a recovery. Senn's theory that wounds above the umbilicus were favorable for recovery was not always upheld by the surgeons who examined the dead on the battle-field. When the small intestines were perforated, death invariably resulted. Makin

reports in the South African War that all the cases in which perforation was diagnosed in the hospital resulted fatally, and that undoubtedly, of the cases that recovered spontaneously, the injury was not of a perforating nature. Watson Cheyne, in *British Medical Journal*, May 12, 1900, reports, from his own experience with wounds of the abdomen, "that the results were not nearly so good as he had been led to believe." The surgeons of the Portland Field Hospital also report that "far too favorable an opinion has been formed of the results of such injuries." On the other hand, in the Spanish-American War there were forty-four penetrating wounds of the abdomen with thirty recoveries. Ojuna reports that 70 per cent. of the Spanish soldiers wounded in the chest and abdomen in the battle of Santiago recovered. He evidently includes non-penetrating wounds in his statement, which materially lessens its value. Robinson reports twenty recoveries out of forty-five cases received at the First Reserve Hospital, Manila. This latter report is misleading, as it does not state out of how many hundreds of cases of abdominal injuries were these forty-five culled. Many of these were undoubtedly on the road to recovery before being shipped to Manila, as the First Reserve Hospital was miles, and sometimes hundreds of miles, from where the wound was received. As Bowlby, the English surgeon, in commenting on Robinson's statement, says, "From what we have been able to learn, we are of the opinion that a considerable number of men shot through the abdomen die very quickly, or within a few hours; and we think that the patients who were seen at the Base Hospitals" (as was the First Reserve) "were to be regarded as men who had either escaped injury of the bowels and bleeding into the peritoneum, or in whom the perforation of the intestines had not been followed by its usual complications. They represented the few survivors of a large number of men who had died from wounds of the abdomen, implicating the small intestines, and were not to be regarded as *in any way* illustrative of the usual results of such injuries." Transverse and oblique wounds of the intestines were always fatal.

Wounds of the large intestine were not as fatal as those of the small. The denser muscular coat assisted in closure of the opening. Also the conditions in the large intestines seemed better for a localized peritonitis and circumscribed abscess similar to those of appendiceal origin. Therefore wounds in the lumbar region were not considered so serious as those nearer the centre of the abdomen.

Wounds of the kidney caused little trouble, and with fatalities about the same as wounds through the extremities. Through the bladder trouble was experienced from extravasation of urine. These injuries were not considered very fatal.

Recapitulating, we find the consensus of English and American surgeons placing abdominal wounds as regarding fatality in the following order: (1) Spleen wounds most fatal of all. (2) Perforating wounds of the small intestine and mesentery. These were more liable in the transverse and oblique passages of the bullet through abdomen. (3) Wounds of the stomach. (4) Wounds of the large intestine. (5) Wounds of bladder. (6) Wounds of liver. (7) Wounds of kidney. (8) Non-perforating wounds of the intestine; the least fatal of all. As a general rule, from the statistics I have examined, I would suggest that, excepting splenic wounds, the mortality of penetrating, anteroposterior abdominal wounds is in inverse ratio to distance from centre of abdomen. In other words, the farther from the centre the greater chance of recovery.

Wounds of bone (Figs. 7, 8, 9, 10), especially those of the long bones, are important from the explosive effect which is here seen. The bones of the skull enclosing the brain give the worst effects. McCormac, in the *Lancet*, August 3, 1895, says, "Explosive effect is due to rapid arrest of the flight of the bullet on piercing fluid matter, and its motion being transferred to parts immediately surrounding, and these again to parts further removed, somewhat as wave circles by throwing a stone into water." This view has been modified since 1895. Schachner, in *ANNALS OF SURGERY*, January, 1900, says, "Explosive

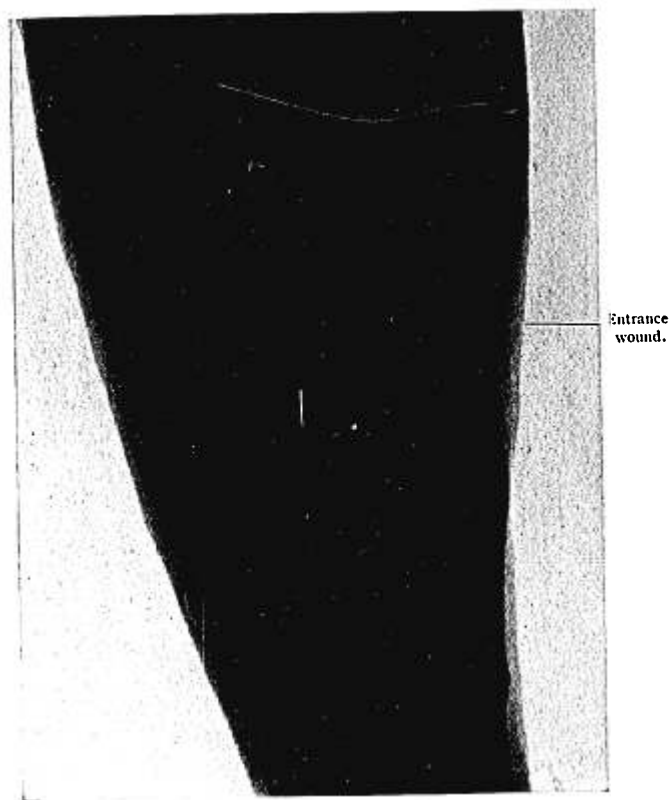


FIG. 7.—Case II. Mauser bullet, undeformed, middle of lower leg, entrance directly over tibia, showing comminution of the same.

Entrance
wound.

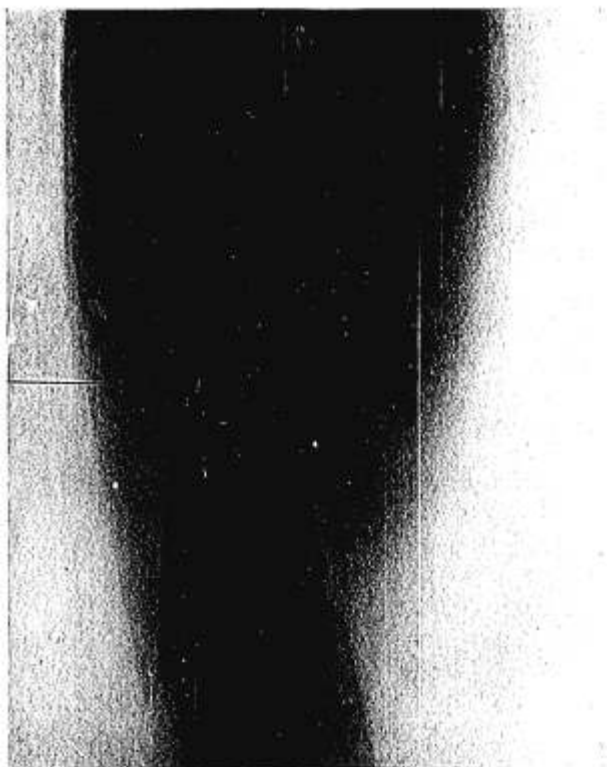


FIG. 8.—Case II. Mauser bullet, undeformed, middle of lower leg, entrance directly over tibia, showing comminution of the same.

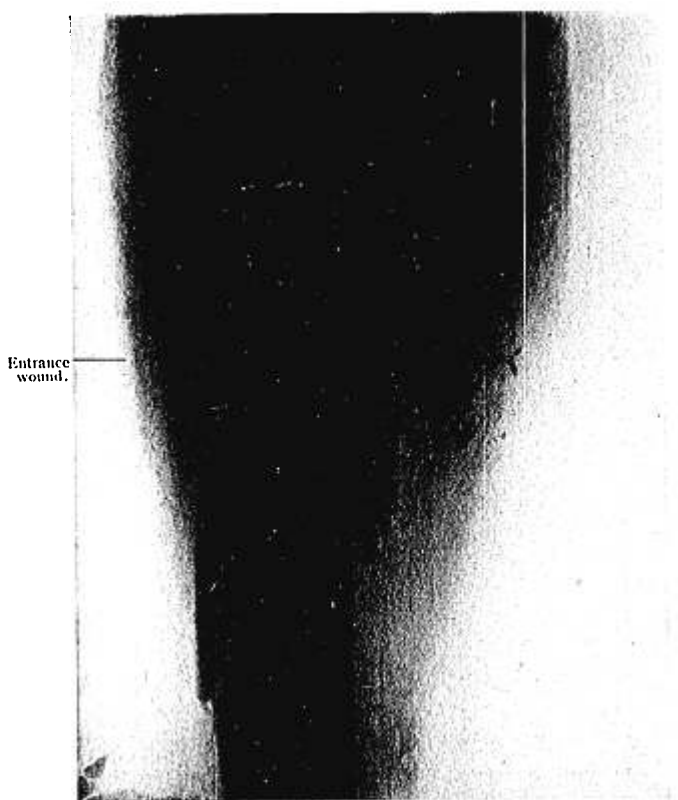


FIG. 9.—Case II. Mauser bullet, undeformed, middle of lower leg, entrance directly over tibia, showing comminution of the same.

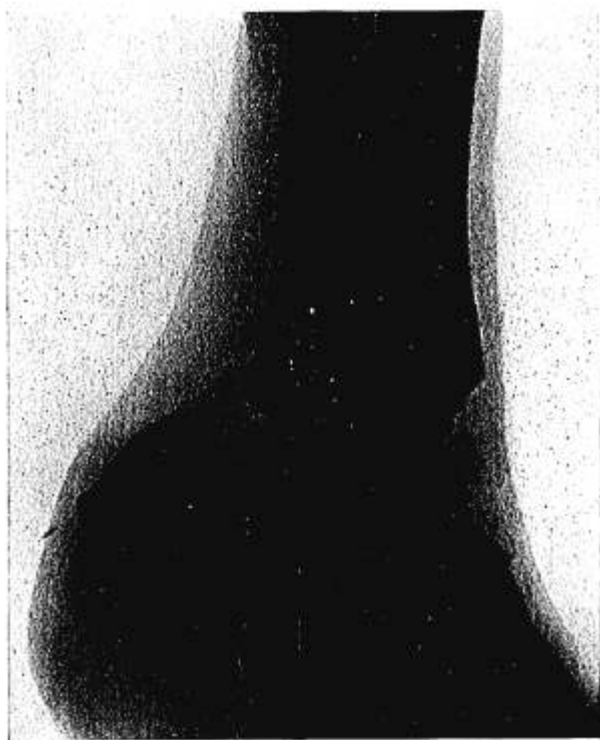


FIG. 10.—Case I.—Mauser bullet undeformed through the malleoli at distance of less than fifty yards.

action is due to the deformation of bullet, range, and character of tissue." He places the range at anything less than 1000 yards. My own experience leads me to believe that the explosive action is due to short range, a hard bone, and soft tissues on the distal side of the bone. The cases of skull injury cited before uphold this theory.

Another case also, Juan Aguinaldo, sergeant of insurgents, shot by Krag carbine, July 7, 1900, at Pasuchin, Luzon. Distance 125 yards. Entrance wound, one-half inch by one-half inch, typical, three inches below internal condyle right femur, course downward and outward, fracturing both tibia and fibula, comminuting the former, so that not a piece three inches long remained. Exit, the whole external surface of the leg, blowing out much of the muscular tissue, and what remained was filled with spicules of bone. The comminution of bone was so extensive, amputation was advised, which I did under spinal anæsthesia, July 8, 1900, the first use of subarachnoid anæsthesia in the Philippines.

Robinson saw twenty-four cases of explosive effect out of 462 cases of bone wounds; all were in long bones or calvarium, and not at extreme range. Von Bergmann, in speaking of wounds of the extremities, remarks that "the wound of exit is usually small, even at close range." This theory is at variance with the experience of American surgeons, who often found a large wound of exit at short range especially. Explosive action can also be due to the filing of the hard apex until the soft core of the bullet is reached. This is then called a "soft-nosed bullet," and "mushrooms" upon striking the harder tissues.

Forwood believes that bullet wounds in bone beyond 600 yards give clean perforations without splintering, especially in spongy bone; while Senn remarks that extensive comminution of bone exists when the distance is within 500 yards; perforation and no splitting in the next 500 yards, and beyond that comminution. English authors do not agree with him, but affirm that the comminuting effect diminishes as the veloc-

ity decreases, and that perforations occur in cancellous bone at any distance, but rarely in the shaft of the long bones. After seeing several hundred cases of bone injuries, I have yet to see a perforation alone except in cancellous bone. In comparison with Civil War wounds we had less transverse fracturing, more longitudinal splintering, the explosive effect in exit wound, the striking contrast of extreme comminution of dense bone, and simple perforation of cancellous, and, finally, the ease with which these wounds healed without amputation. In the Civil War the injuries to extremities showed a fatality of 19 per cent.; in the Spanish-American War but 1.8 per cent.; a decided gain due to high-velocity bullet, aseptic and conservative surgery.

Wounds of the joints made by the small caliber bullet were not much more serious than uncomplicated wounds of soft parts, the cancellous tissue of the joint allowing perforation instead of comminution. Nancrede states there were 161 gunshot wounds of the large joints in the Spanish-American War; seven amputations and one resection made, and only ten deaths out of the entire number wounded. This gives a mortality of 6 per cent. of all cases operated on or not, which is quite different from the records of the Civil War, which of the knee-joint alone treated conservatively shows a mortality of 60 per cent., which percentage would be increased if those operated upon were added. Frederick Smith, however, thinks that, while injuries to the knee-joint have been benefited by the small-caliber bullet, the injuries to the ankle- and wrist-joints are about as bad as with the old bullet. Yet the fact remains that joint injuries are not the serious lesions they were with the old-style bullet.

Blood-vessels have shown a marvellous capacity to escape injury. Makin thinks that this may be due to an effect similar to that seen in a limited train which has been known to throw articles off the track without touching them,—the air in front of it acting as a buffer. Hæmorrhage from the perforated vessels has not been as severe as expected.

I saw one case of the external carotid perforated in an officer; the common carotid was ligated, recovery followed. Another case was that of a native. The external carotid artery and internal jugular vein were both perforated. Ligation in this case did not save him, as several hours had elapsed before I saw the case, and too much hæmorrhage had ensued. The best example, though, is the case of private Saiter, Twelfth Infantry, from Evansville, Indiana. This man was shot from ambush, and, being deserted by his comrades, crawled into the bushes several hundred yards away, and lay there sometime before being found. When brought into the hospital, I found a typical entrance wound, middle external surface, right thigh. Exit, typical at posterior edge, inner condyle of right femur. Diagnosis, perforation of femoral artery in Hunter's canal. Every effort was made to establish collateral circulation without success, and after a week the leg presented that classical color and condition seen when both afferent and efferent blood-vessels are occluded. I amputated at the lower third of the thigh, and found that both vein and artery had been entirely cut through, clots being found in both. It was peculiar to me that fatal hæmorrhage had not occurred at the time of injury, or during the subsequent movements in crawling. Recovery occurred, and patient sent to Evansville.

Aneurisms frequently occurred with the usual involvement of contiguous vessels and structures. The one case I had will be reported under nerve injuries.

Injuries to the nerves occurred with great frequency, both in our own wars and also in the South African campaign. As most of them were concussion and contusion, the resulting paralysis, as a rule, gradually diminished, and in most cases vanished completely. Senn reports one of the cases under my care in his "Practical Surgery."

A hospital corps man was shot at Malabon, Luzon. Entrance wound just below the level of the right shoulder-joint on axillary side of the scapula. Exit, anteriorly, base of axilla and inner border pectoralis major muscle. Paralysis complete from the start. An egg-shaped swelling soon appeared in axilla. Diagnosis, aneurism axillary artery, third portion. When under my

care in June and July, 1899, at the Presidio, San Francisco, the aneurism was compressible, and I recommended ligation. The patient was prepared for operation, but Dr. Senn decided to wait, hoping to have the functions of the nerves involved restored in time without surgical interference. When I last heard of the case in September, 1899, the functions of the median nerve had been re-established, but not those of the ulnar.

The treatment of the bullet wounds has been carefully avoided in this paper, for, as a general rule, they should be treated exactly as those we have in our civil hospitals here at home. However, my own experience, supplemented by the experience of other army surgeons, caused me to always cut down on a large-sized low-velocity bullet, as the Remington, if possible, and lay its track wide open on account of the attendant infection. Also, to leave a small-sized high-velocity bullet alone, hoping it may become encysted. Scores of such bullets are being carried about to-day without any trouble. One of my cases, which Dr. Senn has also reported, has a bullet lying close against the rectum one and a half inches above the sphincter. A radiograph found it there, though the point of entrance was just above the popliteal space. It causes him no trouble at all. Borden reports a case of a soldier who still carries a bullet in the brain without irritation of any kind. Another observation is the enormous recuperative power of bone tissue after gunshot injuries. Very rarely is amputation justifiable. Formerly, it was thought best to amputate in wounds of the joints, but under antiseptic treatment it is rarely, if ever, needed.

The treatment of bullet wounds of the abdomen in war has not been satisfactory from a surgical stand-point. Every one operated on in the Spanish-American War died. Nearly all operated on in the Boer War were fatal. It is impossible to do the patient justice on the battle-field; and while such operations should be performed in civil hospitals where conditions are favorable, so far we have not been able to conduct such operations with success on the field of action, and by the

time the patient is transported to the Base Hospital he has passed the operating time. Conservative treatment alone has given the best results, according to the majority of army surgeons. Gibson insists on the expectant treatment because those who had penetrating wounds of the chest or the abdomen and got well were treated that way. Flagg mentions the fact that for the three years ending June 30, 1901, of the sixteen laparotomies for perforating gunshot wounds of the abdomen in the army, thirteen died. Makin, in his South African experience, notes that, of six bullet perforations of abdomen operated on from three to four days after being wounded, only one recovered; that it was better to operate inside of twelve hours or not at all; that it is better to operate before transportation than afterwards. In nine cases diagnosed as perforations of abdomen and not operated on four recovered, giving a mortality of $83\frac{1}{3}$ per cent. for those operated on, and $55\frac{5}{8}$ per cent. for those treated expectantly without operation. Nancrede is "opposed to operating in the field except under circumstances too exceptional to be noted." Senn straddles the question by stating that there should be "immediate operative treatment of gunshot wounds of the abdomen where hæmorrhage or fatal lesions dictate such a course." Forwood decides on immediate operation or not at all, as wounds of the viscera do not admit of delay. Borden gives forty-four as the total number of penetrating wounds in Spanish-American war, of which number four were operated on, with a mortality of 100 per cent. Of the forty unoperated on there was a mortality of $62\frac{1}{2}$ per cent., and he summarizes "Laparotomy should only be used in those cases in which the surgeon is sure death will occur without it." In the three cases operated on by Banister two died, while the one with a revolver wound recovered. Hildebrand explains some of the mortality in the South African War in that "Not a single case of penetrating wound of the abdomen was operated on in less than three days." Probably such statements as that encourage surgeons like Harris, who believes in drainage and operation in all cases of penetrating wounds of the abdomen. La Garde trusts in the simple aseptic dressing as the best.

Treves has formulated the following rules, which are the clearest and most concise that I have found. In penetrating abdominal bullet wounds he advises operation if (1) Patient is seen before seven hours have elapsed. (2) Patient has had an empty stomach when wounded. (3) Patient has had a short and easy transport. He advises non-interference if (1) Patient not seen until seven hours have elapsed. (2) There has been a long and tedious transport. (3) Patient has been wounded soon after a meal. (4) The liver, spleen, or kidney be wounded. (5) It be a transverse or oblique wound above the umbilicus. (6) The bullet is retained. (7) The wound be below umbilicus, as in this locality the patients generally get along all right. (8) The colon alone be implicated (except the transverse). "It comes to this, that the cases that are suited for abdominal section on the field are, roughly, exceedingly few." Poey hits the nail on the head when he says "Less surgical interference, the better the results ultimately; common sense and antiseptic treatment will do more than all the surgical operations possible."

No less an authority than MacCormac says, "The treatment of the larger portion of Mauser wounds is generally of the expectant kind, and this is especially true of abdominal wounds. But in every region of the body, the percentage of cases terminating fatally is diminished."

That the modern rifle is more humane than the old can no longer be doubted. In the Civil War there was one man killed to every 4.5 wounded; in the Spanish-American and Philippine Wars there was one man killed to every 7.4 wounded. The Civil War has a mortality of the wounded of 13 per cent. The Spanish-American cut this percentage in two, and the records of the hospitals in the Philippines reduced this nearly one-half. In the North China campaign there was a mortality of the wounded in the Japanese army of 3.2 per cent. It is to be hoped that when the accurate statistics of the Russian-Japanese War are published that even this small percentage will be diminished.

From my own experience in Cuba, the Philippines, and China, and from the published records of surgeons who have

participated in active campaigns, the modern bullet is humane. And it seems to me that the treatment should be humane, too, which should seldom be operative, but usually an aseptic conservatism.

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